United States
Department of
Agriculture

Economic
Research
Service

**Natural
Resource
Economics
Division**

The Influence of Water Quality on the Value of Recreational Properties Adjacent to St. Albans Bay, Vermont

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ABSTRACT

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water quality of the bay had depressed adjacent property values by $4,500 on the average, or about 20 percent, compared with similar nearby properties on the larger but cleaner lake.

Keywords: Water quality, hedonic, property values, benefits, Rural Clean Water Program.

PREFACE

The Rural Clean Water Program (RCWP) was enacted by Congress in 1979 to combat agricultural nonpoint source pollution. RCWP is a voluntary program which provides long-term financial and technical assistance to owners and operators of privately held agricultural land in selected project areas who install and maintain best management practices (BMP's) to control water pollution. The Agricultural Stabilization and Conservation Service (ASCS) is responsible for operating the program, with technical assistance provided by other U.S. Department of Agriculture agencies and the U.S. Environmental Protection Agency. The Soil Conservation Service (SCS) coordinates all technical services.

The St. Albans Bay, Vermont, RCWP project was selected for comprehensive monitoring and evaluation (CM&E). The CM&E consists of monitoring and evaluating the physical and the socioeconomic effects of the RCWP project. The Economic Research Service, U.S. Department of Agriculture is cooperating with the University of Vermont, ASCS, and SCS in conducting the socioeconomic evaluation.

The socioeconomic evaluation includes evaluation of RCWP impacts on participants and local agriculture, evaluation of offsite and community impacts, analyses of cost effectiveness, and comparison of the project's benefits and costs. Results reported here are part of the comprehensive socioeconomic evaluation of the St. Albans Bay, Vermont, RCWP project.

CONTENTS

SUMMARY

This study estimates the economic damage due to water pollution on shoreline residential properties located adjacent to St. Albans Bay, Vermont. Only residential land is analyzed, although other types of land use are affected by the pollution problems in the bay. The predominant land use along the bay is residential and it is likely that the majority of property value damages accrue to this category of landowners.

The model used in this analysis is based on the hedonic approach. The underlying assumption for the hedonic approach is that the price of a property is a function of the structural, neighborhood, and environmental quality characteristics of the property.

Ordinary least squares multiple regression analysis is used to estimate the influence of water quality on property values. The model is estimated for both actual prices and for prices adjusted to a 1981 base year. Water quality is initially entered into the regression model as a dummy variable. Water quality is alternatively entered into the adjusted sales price model as a continuous variable which is derived from survey data. The water quality variables are of the expected direction of influence and are significantly different from zero.

The values of shoreline residential properties along St. Albans Bay were found to be adversely affected by the pollution problems in the bay. The average residential property located adjacent to the bay sold for approximately $4,500 less than similar properties located outside the bay as of the last quarter of 1981. This represents approximately 20 percent of the average property value. Since there are approximately 430 single-family dwelling units located along the bay, the aggregate estimate of economic damage to this particular group of landowners is approximately $2 million.

Actual sales price models are used to estimate the level of appreciation in the St. Albans Bay housing market. The subject market is appreciating at approximately the same rate as the average northeastern United States housing market. Properties located adjacent to the bay are appreciating at a lower rate than similar properties located outside the bay.

INTRODUCTION

Poor water quality in St. Albans Bay on Lake Champlain in northern Vermont has been accused of reducing values for nearby shoreline properties (Franklin County, Vt., 1980). The relationship between water quality and property values is examined in this report. An hedonic model is developed and estimated to provide a measure of the influence of water quality on property values and to estimate the benefits that would accrue from improvement of the water quality in St. Albans Bay.

PROBLEM SETTING

St. Albans Bay is situated in the northeastern area of Lake Champlain, approximately 15 miles south of the Canadian border in Franklin County, Vermont. The 1980 county population was 34,788, approximately 7 percent of the State population. The county farm population was 12.5 percent of the total county population in 1980 (U.S. Bureau of the Census, 1980).

The bay, until recent years, has been a major recreational resource to the area, providing swimming, boating, and fishing opportunities. The decline in annual day use of St. Albans Bay State Park from 1960 to 1978 is depicted in figure 1. The apparent decline in park use (and also bay use) is due to water pollution.

A symptom of pollution in St. Albans Bay is extensive macrophyte growth. Eurasian milfoil, water chestnut, and floating yellowheart have thrived in shallow shoreline waters as a result of accelerated euthrophication. An inadequate municipal wastewater treatment plant is a major cause of the pollution. The remainder is attributable to nonpoint agricultural sources. Phosphorus, shown to be the limiting nutrient in Lake Champlain, enters the bay in excessive amounts from both of these sources. Although agriculture (that is, dairy farms) is the primary nonpoint contributor, other nonpoint sources, such as streambank and shoreline erosion, and runoff from road surfaces, road banks, and construction sites, have also been identified (Franklin County, VT, 1980).

Several measures have been undertaken in a shortrun attempt to correct the bay's pollution problems. Treatment with copper sulfate and weed harvesting have been used to reduce the amount of algal and macrophyte growth. These measures could influence results of this analysis by enhancing water quality. Longrun water quality in the bay will also be affected by upgrading St. Albans' wastewater treatment plant and controlling agricultural nonpoint source pollution. However, these factors will not influence the estimated impact of water quality on property values during the time period of this study.

MODEL DEVELOPMENT

Hedonic Technique

Individuals can choose the level of consumption of local public goods through their choice of a jurisdiction in which to reside. Where these choices are possible, information on public goods demand is embedded in the prices and consumption levels for private goods. For example, people could choose their homes according to the area with the least exposure to air pollution. Residential housing prices may include premiums and discounts

Figure 1. St. Albans Bay State Park, annual day use

Source: Vermont Rural Clean Water Program Coordinating Committee. 1982.

for locations in clean or dirty areas. It may be possible to estimate the demand for public goods, such as clean air, from the price differentials revealed in private markets (Freeman, 1979).

The hedonic technique has been widely used to evaluate the effect of environmental quality on residential property values. The technique has been applied primarily to air pollution problems. A limited number of studies have addressed water pollution (David, 1968; Dornbusch and Barranger, 1973; Dornbusch, 1975; and Epp and Al-Ani, 1979).

The hedonic technique is a method for estimating the implicit prices of characteristics which differentiate closely related products in a product class. In an hedonic model, product characteristics are regressed against product value. The hedonic technique was developed by Griliches (1971) initially for the purpose of estimating the value of quality change in consumer goods. The principal conclusions of hedonic theory, as developed by Griliches and refined by Rosen (1974) are that:

(1) The hedonic function is a joint envelope (in characteristics space) of demander's bid curves and seller's offer curves.

(2) Neither supply nor demand for characteristics can be directly identified from the hedonic function, since it is defined only over characteristic space and its arguments consist exclusively of characteristics.

(3) Implicit prices are estimated econometrically by the first step regression analysis (product price regressed on characteristics) in the construction of hedonic price indexes.

(4) The partial derivatives of the function should be interpreted as the implicit marginal characteristic prices prevailing at a particular market equilibrium.

Data Collection

Data on all sales of residential shoreline property along Lake Champlain within St. Albans and Georgia were collected in cooperation with the Franklin County Natural Resource Conservation District. Property transfer tax and tax assessment records were obtained for each subject property for the years 1976 through 1981.

A 6-year study period was chosen primarily to increase the sample size of the study. Because the housing stock (that is, population) in the study area is small, the number of real estate transactions in any year is also expected to be small. A preliminary study indicated that, for 1980 and 1981, there were approximately 40 shoreline

residential transactions in Georgia and St. Albans. Although this is not an unreasonably small data set, there are certain statistical properties of a sample that are enhanced by increasing sample size (Ross, 1976). The pollution problems in St. Albans Bay are a recent phenomenon. We would expect the values of recent transactions (that is, transactions made after 1976) to reflect more of the consumers' decisions regarding water quality than transactions in earlier years (that is, transactions made before 1976).

The resulting sample contained 103 sales. All invalid sales, such as sales to relatives and sales of less than fee interest, were then excluded from the sample. Sales that we believed to be nominally priced were not excluded from the sample primarily because housing prices are arrived at within local markets and what may be considered nominally priced in one market may be average for another. The only relevant property characteristic for which data was not available for all observations was information on lot dimensions. The resulting sample used in the analysis contained 93 observations. The sample can be further explained as follows:

78 observations had frontage and area information.

11 observations had no information regarding lot dimensions.

4 observations had frontage information only.

93 observations in the sample.

Shoreline Characteristics Evaluation

A shoreline characteristics evaluation was conducted in the St. Albans Bay area. The objective of the evaluation was to subjectively evaluate the desirability (that is, scenic beauty, water quality) of various locations along the shoreline of Lake Champlain. The evaluation was developed for two reasons. First, physical measurements (that is, pH, dissolved oxygen) of water quality at specific locations within the study area were not available. Second, we believed that people can perceive water quality differences and that these opinions can be used as a proxy for water quality impacts.

A group of working professionals within local planning or conservation agencies and other longtime residents of the St. Albans Bay area were asked to respond to a series of nine experiments regarding the shoreline on and near St. Albans Bay (appendix). The majority of the experiments were designed to address different aspects of perceived water quality. Experiments 3, 4, 5, 6, 7, and 9 asked respondents to evaluate the points located on the appendix map with regard to water quality. Experiments 1 and 8, although indirectly evaluating surface pollution, asked respondents to rate the points along the lake in terms of

their visual impressions. Experiments 1 and 8 were designed to evaluate the natural features (that is, view of the lake) at various points along the lake. Experiment 2 asked respondents to evaluate the designated locations along the lake with respect to all other factors that contribute to a site's value.

The respondents' opinions regarding the project area are considered expert. Using these expert opinions, we developed several variables to evaluate the quality of water at various locations along the lake. There were two stages in the process of assigning a water quality value for each property. First, the geographic location of a subject property was ascertained. The property was then assigned to one of the 10 locations designated on the appendix map. Second, based on the location of a property, a water quality value was assigned. The values a water quality variable could assume ranged from 1 to 10. High ratings (that is, 6 to 10) were associated with good water quality attributes. Conversely, low ratings (that is, 1 to 5) represented poor water quality attributes.

Identification of the Empirical Model

The empirical model is expressed as:

PRICE = f(LOT, SIZE, QUALITY, PORCH, EXTRAS, TREND, WATER)

where:

PRICE = Sale Price of a Property

LOT = Square Feet of Building Lot or Frontage

SIZE = Square Feet of Living Space

QUALITY = Quality of Building Construction

PORCH = Enclosed Porch

EXTRAS = Extra Buildings

TREND = Quarterly Trend

WATER = Water Quality

The sale prices of the subject properties were verified using property transfer tax records. The assessed values were not used. Property sales prices were preferred to assessed values because they reflect the actual consumer behavior in the market.

The empirical model used both adjusted and actual sales prices. In the adjusted sales price model, property prices were adjusted to the last quarter of 1981, using the implicit price deflators of residential nonfarm structures (U.S. Department of Commerce, 1981). The

average adjusted sales price was $21,652 (table 1). In the actual sales price model, the actual property prices were entered into the model in conjunction with a trend variable reported quarterly. The average actual sales price was $18,649.50 (table 1). It was hypothesized that the Quarterly Trend variable evaluated the influence of water quality and inflation on property values over time.

Tax asessment records were used to ascertain the physical characteristics and location of each property. The following variables were derived from these records:

(1) Square Feet of Building Lot -- This variable accounts for the total area of a property. The variable was reported in square feet and should positively affect property value. The average lot size for properties in the study was more than 35,800 square feet (table 1). However, the median area indicates that 50 percent of the properties in the study were less than 14,250 square feet (table 1).

(2) Frontage -- This variable accounts for the length of property boundary contiguous with Lake Champlain or road right-of-way facing Lake Champlain. The variable was reported in linear feet and should affect property values positively. Frontage averaged 129 feet for the 93 properties in the study (table 1).

(3) Square Feet of Living Space -- This variable accounts for the total amount of living space, not including basement, garage, enclosed porch, or attic space, in a dwelling unit. The variable, which was reported in square feet, provides a measure of the size of a structure and should positively affect property value. The average dwelling unit in the study was approximately 823 square feet (table 1).

(4) Quality of Dwelling Construction -- Each tax assessment record has an evaluation of the quality of construction for a dwelling. The actual range of observed values for this variable was from 23 to 72. High values are associated with superior quality construction. The resulting index should be positively related to property value. The mean of this index for the properties studied was nearly 45 (table 1).

(5) Enclosed Porch -- This dummy variable designates whether or not a property has an enclosed porch. The variable should be positively related to property value. Approximately 60 percent of the properties had this characteristic (table 1).

(6) Extra Buildings -- This dummy variable designates whether or not a property has a garage and/or shed. In almost all cases the properties had both garages and sheds or neither of these attributes. Carports were not

Table 1--Means, standard deviations, and medians of variables included in models

Variable	Number of observations	Mean	Standard deviation	Median
Actual Sales Price ($)	93	18,650	13,237	15,000
Adjusted Sale Price ($)	93	21,653	15,232	19,780
Square Feet of Building Lot (square feet)	78	35,817	83,242	14,250
Frontage (feet)	82	129	128	92
Square Feet of Living Space (square feet)	93	823	361	724
Quality of Dwelling Construction (0=poor to 100=excellent)	93	44.8	9.6	44
Enclosed Porch (porch = 1)	93	.60	.49	1
Extra Buildings (building = 1)	93	.27	.45	0
Quarterly Trend (Jan/Mar 1976 = 1)	93	15	5.9	18
Water Quality Index (Bay = 1)	93	.37	.48	0
WQRATE (1=poor, 10=excellent)	93	4.9	1.7	5.8
WQRANK (1=poor, 10-excellent)	93	6.1	2.4	6.8

considered garages; only detached and integrated garages were considered. The variable should be positively related to property value. About 27 percent of the properties had extra buildings (table 1).

(7) **Quarterly Trend** -- The trend variable was used in the actual sales price models and was reported quarterly, with the first quarter of 1976 set equal to one. Since the study period was from 1976 to 1981, the variable ranged from 1 to 24. The mean value for properties in this study was 15 (table 1). The variable should positively influence sales prices.

(8) **Water Quality Index** -- Initially water quality is entered into the model as a dummy variable, indicating whether a property is located inside the bay or outside the bay (BAY). Since water quality inside the bay is reputed to be inferior to water quality outside the bay, properties located adjacent to the bay will have a value of one for the variable. Conversely, properties located outside the bay will have a value of zero. Of the properties included in this study, 37 percent were located adjacent to the bay (table 1). The variable should be negatively related to sales price, indicating that properties located adjacent to the bay are less valuable because of the bay's severe pollution problems.

Water quality will alternatively be entered into the model as a continuous variable. This variable is derived from the shoreline characteristics evaluation. The variable essentially estimates the value possible housing consumers place on neighboring water quality at various locations within the study area. The variable is an index of perceived water quality.

(9) **WQRATE** -- This is the average rating (among respondents) for each of the 10 location points for question 7. This question specifically asked respondents to rate the water quality at the designated points along the lake. Because of the directness of the question, the WQRATE variable is believed to be highly indicative of the respondents' perception of water quality. The mean of this variable was 4.9 (table 1).

(10) **WQRANK** -- This is the average ranking for each of the 10 location points for question 9. This question asked respondents to rank the various locations from most polluted to least polluted. Although the question specifically states "if you cannot differentiate between two or more points put them on the same line," most respondents assigned each location a unique rank. We believe WQRANK variable is inferior to the WQRATE variable because it suggests that the 10 locations are 10 independent regions, when in reality the distinction may not be that dramatic. For example, a respondent may see no real difference between points 5, 6, and 7 yet a

respondent may think that because there are 10 blank spaces a distinction should be made. The mean of this variable was just over 6 (table 1).

A comparison of ratings between the variables presented in table 2 indicates that point 1, which is the most northern most point evaluated, has the highest value for all variables, whereas point 6, which is located in the heart of St. Albans Bay, consistently has the lowest value for all variables.

The wide range of values for the WQRANK variable is due to the ranking aspect of question 9. We believe that this variable overestimates the differences in water quality among locations.

EMPIRICAL RESULTS

The objective of this analysis was to determine whether water quality affected the value of properties located adjacent to St. Albans Bay, Vermont. To accomplish this objective, the hedonic price equation was estimated for both adjusted and actual sales prices. The adjusted sales price model permitted us to measure the value of water quality and other characteristics capitalized into property values at a specific point in time for the same consumers. The actual sales price models were used to measure the appreciation or depreciation of properties within the St. Albans Bay housing market. The value of water quality (and other amenities) within the actual sales price models represents a gross average of values over time, and because the value of amenities is reported in nonconstant dollars, their estimators will not reflect implicit prices prevailing at a particular market equilibrium. However, the Quarterly Trend variable, used to account for changes in the general level of prices in a market, will not be biased because the purpose of the variable is to estimate the average increase in property values per quarter.

Water quality, which is of primary concern, is initially entered into the resulting regression models as a dummy variable. Since we hypothesize that water quality within St. Albans Bay is lower than water quality outside the bay, properties located adjacent to the bay have a value of one for this variable. Conversely, properties located outside the bay have a value of zero. Properties located near points 4, 5, 6, 7, 8, and 9 were considered to be inside the bay (appendix map). Since the water in the inner bay near points 5, 6 and 7 is the most severely polluted, the use of two dummy variables, inner and outer bay, were also evaluated.

We took a more subjective approach to analyze the impact of pollution on residential property within the bay. In this analysis, water quality was entered into the model as a continuous variable. This order-of-magnitude type variable, derived from the shoreline characteristics

Table 2--Comparison of rating values for the alternative specifications of the water quality variables by location

Point	Bay	WQRATE[a]	WQRANK[a]
Point 1	0	7.21	9.00
Point 2	0	6.23	7.23
Point 3	0	5.75	6.8
Point 4	1	4.41	5.05
Point 5	1	2.82	3.05
Point 6	1	1.58	1.35
Point 7	1	2.05	2.83
Point 8	1	4.15	5.23
Point 9	1	5.40	6.18
Point 10	0	6.35	8.81

[a] 1 = poor, 10 = excellent

evaluation, estimated the value placed on neighboring water quality by potential housing consumers at various locations within the study area.

Specifications of the Empirical Model

The regression models used in the analysis include the basic variables believed to influence property values within the real estate market under study. These variables are: Frontage, Square Feet of Building Lot, Square Feet of Living Space, Locational Index, Quality of Dwelling Construction, Enclosed Porch, Extra Buildings (that is, shed and garage), and, in the models using actual sales prices as the dependent variable, a Quarterly Trend variable. Other factors, not included in the model could influence property values; these potential variables are assumed to be relatively constant or to exert a minor influence on property values.

All characteristics relevant to the determination of market price, that is, those that yield utility to residents and are costly to produce, should be included. In practice, this cannot be done because the number of such characteristics is unmanageably large. Furthermore, in many cases data on these characteristics is either unavailable or of exceedingly poor quality (Butler, 1982). Even without data constraints, the presence of many highly intercorrelated explanatory variables may add little to the descriptive abilities of the model while, increasing the problem of collinearity between these variables (Neter and Wasserman, 1974). For these reasons, any estimate of the hedonic relationship will be misspecified, to a limited degree, because some of the relevant independent variables will inevitably be omitted (Butler, 1982).

In reviewing the numerous articles that report estimates of the price-characteristics relationships for housing markets, we found a diversity of views about the correct specification of this relationship (Freeman 1979). The appropriate specification of the model employed essentially depends on the nature of the problem and the market under study. Butler (1982) contends that approximately correct models can be achieved with significantly fewer characteristics than is generally supposed.

Base Results

The effect of water quality initially was entered into the hedonic model using a zero-one variable for a location adjacent to St. Albans Bay. Results for this analysis, using a linear specification of the hedonic model, are presented in table 3. For the analysis, the dependent variable (sales price) was adjusted to a last quarter of 1981 base value. All coefficients in the model (table 3) had the anticipated sign and the coefficients were significantly different from zero at the 90 percent significance level or better. The estimated R^2 values for the model were found to be around 0.68 (table 3). Since residential property cannot be considered a homogeneous good and

Table 3--Regression results for adjusted sales price models

Variable	Coefficient value (Student-t) (1)	(2)	(3)
Constant	-16,025.5 (2.95)***	-15,832.2 (3.03)***	-17,230.1 (3.60)***
Frontage (feet)	---	15.69 (1.74)*	---
Square Feet of Living Space (square feet)	7.49 (2.19)**	7.34 (2.20)**	6.79 (2.10)**
Locational Index (Bay=1)	-4,339.12 (2.05)**	-4,690.18 (2.30)**	-4,136.79 (2.14)**
Square Feet of Building Lot (square feet)	.03 (1.83)*	---	---
Quality of Dwelling Construction (0 = poor, 100 = excellent)	576.07 (4.43)***	538.76 (4.31)***	604.12 (5.20)***
Enclosed Porch (porch = 1)	7,050.30 (3.30)***	7,966.58 (3.87)***	7,878.89 (4.06)***
Extra Buildings (building = 1)	9,909.65 (3.59)***	9,749.93 (3.55)***	11,693.95 (4.65)***
R^2	.68	.67	.68
D.F.	71	75	87

--- = not included in the model
* Significant at 0.10 probability level (two-tailed t-test).
** Significant at 0.05 probability level (two-tailed t-test).
*** Significant at 0.01 probability level (two-tailed t-test).

residential markets cannot be considered perfectly competitive, an R^2 of this magnitude for a cross-sectional study using primary data seems to be quite reasonable. The results revealed no statistical problems such as multicolinearity or heteroskedasticity.

Three specifications of the model are reported in table 3. The difference between the specifications centers around the description of lot dimensions. In the first equation, lot dimensions are entered as square feet of the building lot. A frontage variable is used in the second specification, and, in the third lot dimensions variables are not included in the model. The lot dimensions variable was the limiting factor in terms of available data.

In real estate appraisal practice, comparisons in land analysis include both frontage and area (American Institute of Real Estate Appraisers, 1978). In regression analysis, the simultaneous inclusion of these variables will probably introduce collinearity in the model. For this study, we perceived frontage to be a more important factor than area because the added utility derived from greater accessibility to the lake is assumed to be greater than the added utility of a deeper lot.

The regression results imply that there is not an excessive premium placed on houses with larger lots. The coefficient for the Square Feet of Building Lot variable is extremely small, indicating an additional square foot of building lot would equal \$0.025, whereas, an additional front foot equals \$15.69, using the adjusted sales price models (table 3, equations 1 and 2). As depth increases beyond the typical, the value per unit of frontage tends to increase, but the square foot or acreage unit value tends to decrease (American Institute of Real Estate Appraisers, 1978). For example, the mean level of lot dimensions within the study area is 129 feet (frontage) x 191 feet (depth). An additional front foot would increase the value of a lot with these dimensions by \$15.69. The total increase in lot size is 129 square feet. The additional value of the lot, using the lot size variable, would be \$3.23. Although the increase in acreage is the same, the value added, due to an increase in backland, is smaller than the added value due to an increase in frontage.

Hedonic price theory suggests that relevant price estimates for individual characteristics can be derived from the estimated models. Since the coefficient of the Square Feet of Living Space variable is equal to its implicit price, we would expect that, as of the last quarter of 1981, a square foot of living space would be appraised between \$6.79 to \$7.49,holding other factors constant.

An increase in the quality of the construction would increase property value between $539 to $604 for each one-unit increase in the quality index.

The Enclosed Porch and Extra Buildings (that is, garages and sheds) variables are entered into the model as dummy variables. A property is designated as either having both of these structures or as having neither.The size of the structure,[1/] although disregarded in this analysis, is obviously relevant to market price. The quality of an enclosed porch is accounted for, to an extent, in the quality of dwelling construction variable; however, the quality of a garage is not accounted for in the model.

The Enclosed Porch and Extra Buildings variables, although highly significant in the estimated models, appear to be misleading. There is little doubt that the existence of either an enclosed porch or garage would enhance a property's value. However, the relative contribution of these variables within the price equations is exorbitant. Again, if we view the coefficient of a porch as being equal to its implicit price, a dwelling with an enclosed porch would cost approximately $7,050 to $7,967,using the adjusted sales price models (table 3), more than a property without a porch. The typical porch size within the sample is at most 300 square feet, which reflects a fair market price of more than $23.50 per square foot. In comparison to a price of approximately $7.12 per square foot of living space, we believe this price to be excessive. It is possible that these variables are capturing other factors that influence property values, and, as a consequence, are being artificially inflated. We hypothesized that properties with these amenities (that is, porches, garages) are maintained in a superior fashion as compared to properties without these attributes. These variables may be positively influenced by these other factors which are not accounted for in the model.

This analysis focuses on the relationship between water quality and property value. This relationship can be used to estimate the benefits that would accrue to property owners due to water quality improvements in St. Albans Bay. A location adjacent to St. Albans Bay reduced the value of recreational homes by $4,138 to $4,690 (table 3). The zero-one nature of the bay dummy variable restricts the usefulness of the model results, because it does not permit us to evaluate alternative levels of water quality.

We extended the analysis to evaluate three alternative specifications of the water quality variable (table 4). First, the bay dummy variable was divided into two variables: one for the inner bay and one for the outer bay. We did not expect the results for this specification. Since water quality is poorer in the inner bay, we hypothesized that properties adjacent to the inner bay would be worth less than properties adjacent to the outer

Table 4--Regression results for the adjusted sales price model including alternative specifications of the water quality variable

Variable	Coefficient value (Student - t)		
Constant	-16,403.7 (-3.12)***	-23,841.5 (4.11)***	-21,998.9 (3.91)***
Lake Frontage (feet)	14.89 (1.65)	16.38 (1.83)*	16.09 (1.78)*
Square Feet of Living Space (square feet)	7.89 (2.33)**	6.76 (2.02)**	6.76 (2.00)**
Inner Bay (inner bay = 1)	-3,781.70 (1.68)*	---	---
Outer Bay (outer bay = 1)	-7,119.91 (-2.15)**	---	---
WQRATE (1=poor, 10=excellent)	---	1,417.08 (2.53)***	---
WQRANK (1=poor, 10=excellent)	---	---	912.29 (2.25)**
Enclosed Porch (porch = 1)	7997.87 (3.88)***	7,985.32 (3.90)***	7,982.54 (3.87)***
Extra Buildings (buildings = 1)	9,452.00 (3.42)***	9,836.14 (3.60)***	10,016.20 (3.63)***
Quality of Dwelling Construction (0=poor, 100=excellent)	545.70 (4.36)***	529.20 (4.26)***	521.81 (4.17)***
R^2	.68	.68	.67
D.F.	74	75	75

--- = not included in the model
* Significant at 0.10 probability level (two-tailed t-test).
** Significant at 0.05 probability level (two-tailed t-test).
*** Significant at 0.01 probability level (two-tailed t-test).

bay.[2/] The second specification uses the water quality rating derived from the shoreline characteristics evaluation. The final specification uses the water quality ranking from the shoreline characteristics evaluation.

The latter two specifications of the water quality variable have some appeal since they represent the attitudes and opinions of potential consumers regarding water quality at various locations in the study area. Also, the use of these variables results in a continuous specification of the water quality variable which permits us to estimate the influence of alternative water quality levels at various locations. We preferred the water quality rating specification because it permitted clearer distinctions between alternative sites.

A comparison between the Bay and WQRATE models with respect to the value of water quality indicates that the models operate in a similar fashion. For example, using the WQRATE variable, we found the average rating for properties located adjacent to the bay to be 3.41 (table 2). The average rating for properties outside of the bay is 6.38. The difference in the ratings is 2.97. The estimates indicate that properties located outside the bay sell for approximately $4,200 (2.97 times $1,417) more than properties located adjacent to the bay, all other factors remaining equal. This estimate of economic damage to bay properties by water pollution for the bay properties further supports the $4,500 estimate derived from the models presented in table 3.

The water quality estimates could be capturing the influence of other factors not accounted for in the model. Two factors not accounted for in this analysis are view and the advantages of a bay location associated with protection from the weather. If the view from the main lake is better than the view from the bay, the estimates of water quality impacts will be somewhat overstated. Conversely, the benefits will be understated if the view is better from the bay. If there are advantages to bay locations associated with protection from the weather for boat docking or property maintenance, the estimates of water quality impacts may be understated. Evaluation of the shoreline within the study area indicates a greater density of recreational properties inside the bay when compared to the main lake (50 versus 23 properties per mile of shoreline). This implies the possible existence of unmeasured benefits, such as protection from the weather associated with bay locations.

Actual Sales Price Models

The impact of water quality degradation in St. Albans Bay has occurred over a period of time. Since property sales data were collected for a 6-year period, this temporal effect of water pollution can be examined in a limited manner. To accomplish this we respecified the model to

include an additional independent variable, Quarterly Trend, to be regressed against actual sales prices.

The St. Albans Bay real estate market for seasonal homes can be characterized as an appreciating market for the years 1976 through 1981. Actual sales prices increased by approximately $330 for each quarter (table 5). This translates into an approximate appreciation rate of $1,320 per year for an average quarterly inflation adjustment within the adjusted sales price model. The sample of property prices was adjusted to the base period (the last quarter of 1981) using the northeastern United States implicit housing deflator.[3/] The estimated average quarterly adjustment for inflation is approximately $274.[4/] Since the Quarterly Trend variable estimates the actual inflation rate up until the last quarter of 1981, and the inflation adjustment indexes all sales to the last quarter of 1981, these rates should be identical if the inflation rate within the St. Albans Bay real estate market is equal to the average inflation rate occurring within the northeastern United State housing market. The results indicate that the subject market is appreciating at approximately the same rate as the average northeastern residential real estate market.

The Quarterly Trend variable reported in table 5 represents an aggregate level of appreciation within the general St. Albans Bay housing market. While the market, in general, may be appreciating at the same rate as the average residential market in the Northeast, the appreciation rate of the housing stock in the bay compared to the appreciation rate outside the bay may differ. Investments in real estate in the bay are competing, in regard to the advantages offered, with investments outside the bay. If the advantages offered for a dwelling in the bay are perceived by consumers to be less than the advantages offered or utility derived from a dwelling outside the bay, the real estate market will be more active outside the bay.[5/] Low activity indicates a depressed market (in other words, low aggregate demand). The severe pollution problems in the bay are a definite disadvantage to the bay properties. We hypothesized that a lower appreciation rate for properties adjacent to the bay indicates that these properties are inferior to properties outside the bay because of the pollution externality.

The Chow Test was used to determine whether there is a difference in appreciation rates. The test determines whether the intercepts and/or slope coefficients are different between two regressions (Chow, 1960). The following test statistic is used:

Table 5--Regression results for actual sales price models

Variable	Coefficient Value (1)	(2)
Constant	-18,207.5 (3.51)***	-17,603.3 (3.51)***
Frontage (feet)	---	12.77 (1.64)*
Square Feet of Living Space (square feet)	6.31 (2.18)**	6.23 (2.17)**
Locational Index (Bay=1)	-3,622.03 (2.02)**	-3,942.45 (2.26)**
Square Feet of Building Lot (square feet)	.02 (1.83)*	---
Quality of Dwelling Construction (0=poor, 100=excellent)	484.13 (4.43)***	448.68 (4.19)***
Enclosed Porch (+) (porch = 1)	5,686.12 (3.12)***	6,608.63 (3.71)***
Extra Buildings (+) (buildings = 1)	8,786.68 (3.12)***	8,667.71 (3.62)***
Quarterly Trend (Jan/Mar 1976 = 1)	332.02 (2.21)**	326.34 (2.21)**
R^2	.70	.68
D.F.	70	74

--- = not included in the model.
* Significant at 0.10 probability level (two-tailed t-test).
** Significant at 0.05 probability level (two-tailed t-test).
*** Significant at 0.01 probability level (two-tailed t-test).

$$F = \frac{RSS_1 - (RSS_2 + RSS_3) / K}{(RSS_2 + RSS_3) / (N_2 + N_3 - 2K)}$$

where:

RSS_1 = residual sum of squares for the pooled data model.

RSS_2 = residual sum of squares for the in the bay model.

RSS_3 = residual sum of squares for the out of the bay model.

N_2 = number of observations for the in the bay model.

N_3 = number of observations for the out of the bay model.

K = number of parameters estimated.

For the Chow Test, points 4, 5, 6, 7, 8, and 9 were considered to be in the bay (appendix map). All other points were considered to be out of the bay. The Chow F was computed using the residual sums of squares from the regression models reported in table 6.

Applying this test, we found that the computed F = 31.67 exceeds the critical $F(0.05;\ 7,\ 60) = 2.17$; the hypothesis that the regression equations are the same is rejected. Since we concluded that the regression equations are different, a comparison of relevant statistics should be made between in and out of the bay models (table 6). All explanatory variables are significant at the 0.95 level and are of the expected direction of influence for the out of the bay model. The results indicate that the appreciation level for properties outside the bay is approximately $423 per quarter. The estimate of the appreciation rate for the in the bay model (table 6) is not significantly different from zero, and it may be interpreted that the inflation rate is effectively zero. While weak statistical inferences can be drawn from the appreciation estimate for the in the bay model, the fact that other variables (which we would expect to be significant) are not significantly different than zero is problematic.

We hypothesized that parameter estimates are not significant for the in the bay model because the sample size (that is, n = 31) was too small. To adjust for this problem, it was necessary to develop a variable (that is, Bay*Trend) that would estimate the appreciation rate for properties in the bay within the context of a pooled data model (table 7). If a property is located outside the bay, the Bay*Trend variable[6/] would equal zero, and,

Table 6--Regression results for chow test using actual sales prices

Variable	Coefficient Value (Student-t)		
	Pooled data	In the bay	Out of the bay
Constant	-19,789.2 (3.78)***	-10,938.7 (1.52)	25,894.4 (3.82)***
Square Feet of Living Space (square feet)	6.61 (2.24)**	-2.62 (.58)	11.56 (3.18)***
Square Feet of Building Lot (square feet)	.02 (1.91)*	-.01 (.47)	.03 (2.16)***
Quality of Dwelling Construction (0=poor, 100=excellent)	480.41 (4.31)**	470.51 (2.85)***	531.10 (3.79)***
Enclosed Porch (porch = 1)	5,293.87 (2.86)***	5,076.66 (1.97)**	5,982.49 (2.30)***
Extra Building (building = 1)	8,528.51 (3.54)***	13,483.16 (4.12)***	6,540.38 (1.91)**
Quarterly Trend (Jan/Mar 1976 = 1)	353.52 (2.31)**	129.25 (.67)	423.61 (2.06)**
R^2	.68	.66	.76
RSS	4,308,068,203	924,175,738	2,530,699,766
D.F.	71	24	40

* Significant at 0.10 probability level (two-tailed t-test).
** Significant at 0.05 probability level (two-tailed t-test).
*** Significant at 0.01 probability level (two-tailed t-test).

Table 7--Pooled data model using actual sales prices and a trend shift variable

Variable	Coefficient value (Student-t)
Constant	-19,485.4 (3.82)***
Square Feet of Building Lot (square feet)	.02 (1.82)*
Square Feet of Living Space (square feet)	6.25 (2.17)**
Enclosed Porch (porch = 1)	5,557.33 (3.08)***
Extra Buildings (buildings = 1)	9,000.94 (3.82)***
Quality of Dwelling Construction (0=poor, 100=excellent)	478.68 (4.40)***
Quarterly Trend (1976-81) (Jan/Mar 1976 = 1)	438.29 (2.85)***
Bay*Trend	-251.20 (2.19)**
R^2	.70
D.F.	69

* Significant at 0.10 probability level (two-tailed t-test).
** Significant at 0.05 probability level (two-tailed t-test).
*** Significant at 0.01 probability level (two-tailed t-test).

therefore, the appreciation rate for this property would be equal to Quarterly Trend or approximately $438 per quarter. This estimate further supports the estimate of inflation derived from the out of the bay model (that is, $423 per quarter) reported in table 6. If a property is located within the bay, the quarterly inflation rate would be equal to Quarterly Trend plus Bay*Trend (or $438 - $251 = $187 per quarter). Both Quarterly Trend and Bay*Trend variables are significant at the 0.95 level and are of the expected direction of influence.

This analysis is based on the assumption that all factors that influence land values in and out of the bay are relatively equal, except for the water quality level. This assumption can be supported by comparing the in the bay and out of the bay models (table 6, equations 2 and 3) with respect to the mean level of their variables (table 8). The two samples appear to be highly comparable with respect to all variables (that is, housing characteristics), except for the Square Feet of Building Lot and Actual Sales Price variables. The higher mean and standard deviation for the Square Feet of Building Lot variable in the out of the bay model (table 8) is due to several large residential properties located in the outer bay market. The lower mean of Actual Sales Price (table 8) and the lower appreciation rate (table 7) for properties located adjacent to the bay indicates that the market is depressed compared to the outer bay market. Again, the depressed market conditions are attributed to lower water quality in the bay.

Although the value of amenities is somewhat distorted in the model,including the Bay*Trend variable (table 7), this model can be used to show the effect of changes in water quality on residential properties over time. Since water pollution directly affects value, and, therefore, the appreciation rate of a dwelling, the lower appreciation rate of properties located inside the bay as compared to properties outside the bay, indicates a deterioration of value over time. Figure 2 depicts the appreciation in property values inside the bay compared to outside the bay.[7/] The figure implies that the appreciation rate for properties located outside the bay is greater than properties inside the bay. However, this scenario may be an overestimate of the true relationship because it assumes that the appreciation rates of the two groups will continue at past levels. In other words, we found the relationship between the two groups with respect to appreciation to be linear within the limited range of the data. Therefore, for the years after 1981 (the last year of the study), the relationship may not hold. Conversely, the figure also implies that for the years before 1976 (the first year of the study), there was no difference between the two groups with respect to appreciation.[8/] This conclusion may be an underestimation of the true relationship. While there is a definite difference in

Table 8 -- Means and standard deviations for the variables included in the in the bay and out of the bay models.

Variable	In the bay Mean	In the bay Standard deviation	Out of the bay Mean	Out of the bay Standard deviation
Actual Sale Price ($)	17,445.17	9,481.66	20,594.25	15,092.38
Square Feet of Living Space (square feet)	829.29	356.87	844.36	380.33
Square Feet of Building Lot (square feet)	32,572.87	49,672.24	37,957.19	99,889.38
Quality of Dwelling Construction (0=poor, 100=excellent)	45.93	8.50	45.65	10.09
Enclosed Porch (porch = 1)	.64	.48	.53	.50
Extra Buildings (buildings = 1)	.32	.47	.30	.46
Quarterly Trend (Jan/Mar 1976 = 1)	13.9	6.25	14.8	5.75

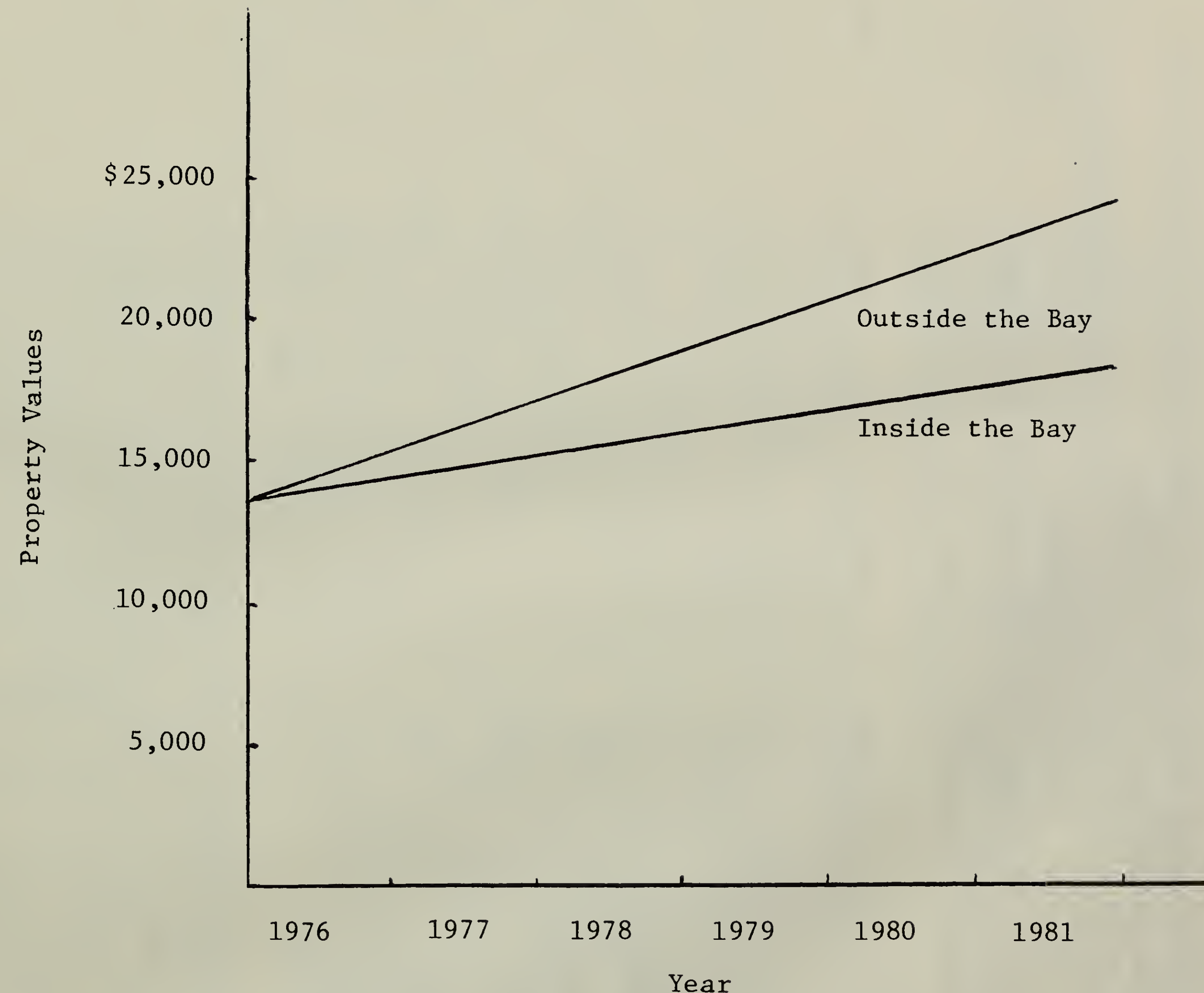

Figure 2. Inflation rate for properties located adjacent to the bay as compared to outside the bay

appreciation rates for the two groups within the relevant range of the study, we can only draw weak conclusions for the years preceding and succeeding this period.

IMPLICATIONS

The value of shoreline residential properties along St. Albans Bay, Vermont, were adversely affected by pollution problems in the bay. We estimate that the average residential property located along the bay sells for approximately $4,500 (as of the last quarter of 1981) less than similar properties located outside the bay. The $4,500 represents approximately 20 percent of the total value of these properties. We hypothesize that other types of property (that is, commercial, parkland) located along the bay, although not accounted for in the model, are also adversely affected. However, the predominant land use along the bay is residential, and it is to this category of landowners that the majority of economic damages accrue. Since there are approximately 430 single-family, residential dwelling units located along the bay, the aggregate estimate of damages to this particular group of landowners is approximately $2 million. This estimate is indexed to the last quarter of 1981; therefore, it actually represents an underestimate if considered in present dollars. In addition, other types of property which we believe to be adversely affected by the pollution problems, are not accounted for in the model and, therefore, are not reflected in the aggregate damage estimate.

For the most part, the economic damages due to water pollution in the bay are recreational. Because the bay is polluted, the recreational potential of the resource is lessened in comparison with other regional recreation areas. We further hypothesize that land uses around the bay, other than residential or recreational, are not as severely economically damaged.

The objective of the Rural Clean Water Program is not only to monitor and evaluate the impact of pollution in the bay, but it is an ongoing effort to restore bay water quality. Although a major benefit would be the restoration of bay property values other benefits are improved wildlife habitat, enhanced environmental aesthetics, and full recreational use of the bay.

The estimated costs of bay pollution, which can be viewed as the potential benefits from pollution abatement, will eventually be incorporated into a comprehensive Rural Clean Water Program cost-benefit analysis for St. Albans Bay. Cost-benefit analysis is a tool for systematically developing useful information about the desirable or undesirable effects of public sector projects (Anderson and Settle, 1977). The estimated costs of pollution are effectively entered into the cost-benefit analysis as a measure of the benefits of water quality improvement.

Since the value of water quality is not estimated with respect to levels of various water quality measurements, the value of abatement cannot be discussed with regard to changes in these measurements. Alternatively, the value of abatement can only be discussed with respect to comparisons between various locations in the study area. For example, using the water quality dummy variable (table 3), we found that if the level of water quality at points 4, 5, 6, 7, 8, and 9 (appendix map) was improved to the level of water quality at points 1, 2, 3, and 10, then the average increase in value for properties located along the bay would be approximately $4,500 (table 3). For this analysis, water quality changes of this magnitude can be considered 100-percent abatement.

The water quality rating system can be used to estimate the value of less than total abatement. Using the estimate of water quality derived from the WQRATE variable (tables 10 and 11), we found that if the water quality at point 6 was improved to the level of the water quality at point 8 (appendix map), the increase in value of properties located near point 6 would be approximately $3,600. Total benefits accruing to property owners would be $1,548,000. The value of water quality is not estimated with respect to levels of various water quality measurements; therefore, the level of abatement which this comparison represents is unknown.

The site specific study described in this report has limited use in generalizing to other areas. The estimated economic damage caused by poor water quality to shoreline residential properties located along St. Albans Bay should not be compared with regional studies. However, the methods employed in this study could be used in related efforts.

When evaluating these benefit estimates, you should keep in mind that property value data reflect only benefits to property owners, not to others who make use of the water body (Freeman). In the case of St. Albans Bay, there are a substantial number of nonproperty owners who recreate in the bay. Ribaudo and Epp (1983) estimate that approximately 26,100 user-days were spent on St. Albans Bay in 1982. Using a travel cost model, they estimate that if water quality were improved, $536,700 worth of benefits would accrue annually to nonproperty owners. Thus, the value estimates presented in this report show only a portion of the likely benefits from improving the water quality in St. Albans Bay.

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FOOTNOTES

1/ It was impossible to estimate the size of an enclosed porch for all dwellings because this information was unavailable for approximately 40 percent of the observations.

2/ The lower value associated with properties adjacent to the outer bay may be due in part to road access problems. Access to the outer bay properties requires more travel on the narrow roadway adjacent to the bay. At the far end of the bay (outer bay) the water quality is still poorer than that of the main lake and there are no offsetting location advantages.

3/ The inflation adjustment is not derived within the sample or region. Sales prices were inflated to the base year as if the actual inflation rate in the subject real estate market was equal to the average residential market in the Northeast.

4/ The total adjustment warranted for inflation during 1976 to 1981 was divided by the total number of quarters for the study, which is equal to the average adjustment per quarter for inflation. The average adjustment per quarter was then multiplied by the mean of actual sales prices, which would equal the average dollar adjustment per quarter for inflation.

$$\frac{.352}{24}\ \begin{array}{c}\text{average}\\ \text{adjustment}\\ \text{per quarter}\end{array} \times 18{,}649\ \begin{array}{c}\text{mean}\\ \text{sale}\\ \text{price}\end{array} = 274.14\ \begin{array}{c}\text{average}\\ \text{dollar}\\ \text{adjustment}\\ \text{per quarter}\end{array}$$

5/ Activity is defined as the number of real estate transactions in a market.

6/ The Bay*Trend variable is defined as Bay (that is, dummy) times Quarterly Trend.

7/ The figure is derived from the inflation estimates reported in the model presented in table 7.

8/ The model presented in table 7 was also estimated including an intercept shifter (that is, bay = 1). The intercept shifter would estimate the average difference between the in the bay and out of the bay data (table 6) for all years. Because of the collinear relationship between the Bay*Trend and intercept shifter variables, both variables were found to be not significant when included in the model together.

APPENDIX

Introduction

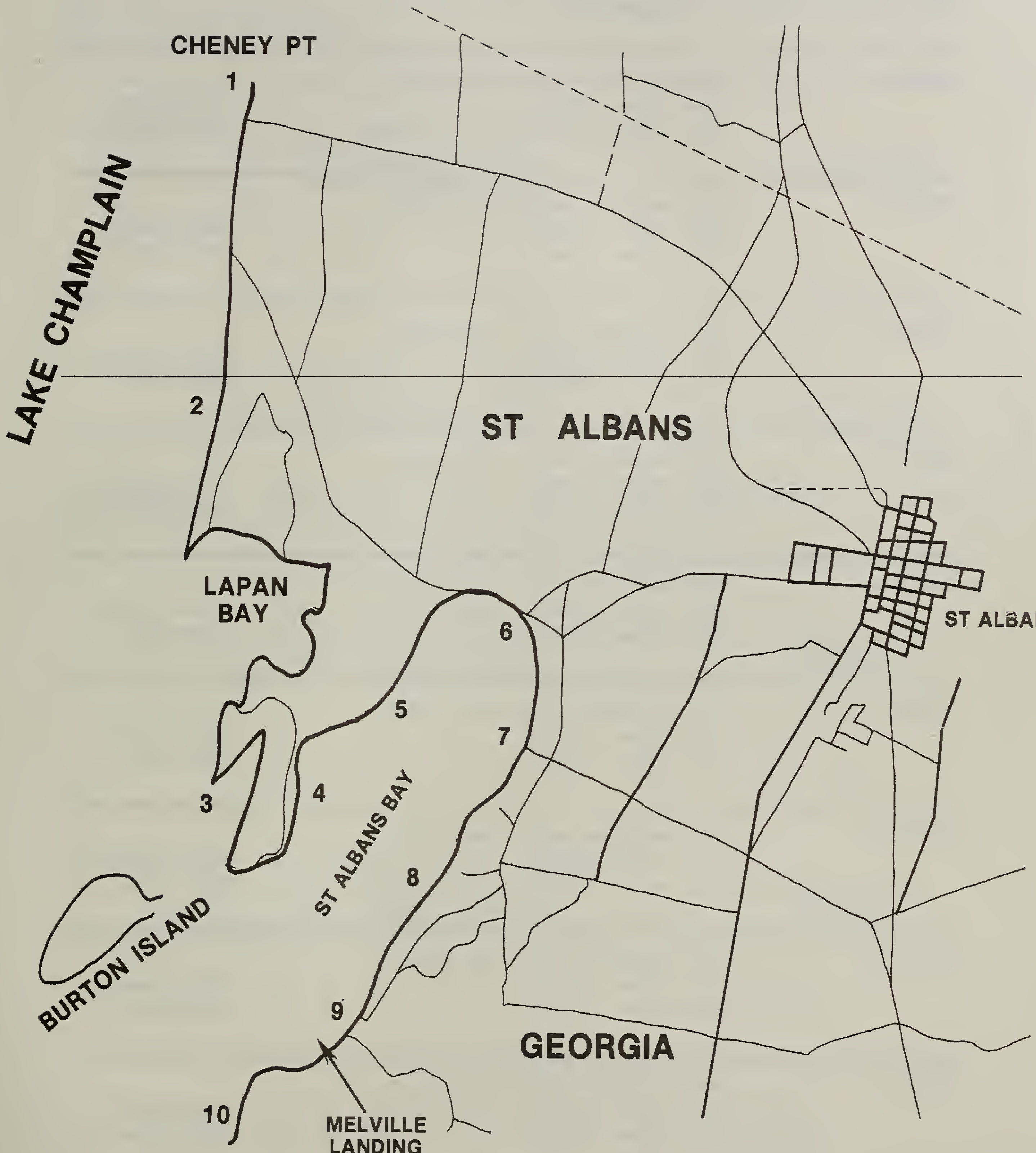
Evaluation of the St. Albans Bay Rural Clean Water Program project comprises more than simple assessments of the agricultural impacts of the project. The impact of agricultural runoff control on the receiving bodies of water is yet to be determined. These impacts must then be translated into effects on people.

The following is an exercise to aid in the translation process. Information is needed on individuals' perceptions of the shoreline characteristics of Lake Champlain in the towns of St. Albans and Georgia.

Instructions

Attached is a map of the Lake Champlain shoreline in the towns of St. Albans and Georgia. There are 10 points identified on the map.

Next are a series of nine experiments. Each experiment asks for a rating of the 10 points identified on the map. Each respondent was asked to check whether the point is "good" or "bad" for the activity indicated,and then to rate the point on a scale of one to five, by circling the appropriate number following the attribute checked. A summary of the average rating for each location point for all of the experiments is included in table 9.



Map. St. Albans Bay, Lake Champlain, Vermont.

Experiment 1 -- Imagine you are standing along the shoreline of Lake Champlain at the points designated on this map. Please rate the following vantage points according to your visual perceptions (i.e., the view of the lake at each point).

****

POINT 1 ______ Not familiar with the point.
______ Good view (Fair) 1 2 3 4 5 (Excellent)
______ Poor view (Fair) 1 2 3 4 5 (Terrible)

****

POINT 2 ______ Not familiar with the point.
______ Good view (Fair) 1 2 3 4 5 (Excellent)
______ Poor view (Fair) 1 2 3 4 5 (Terrible)

****

POINT 3 ______ Not familiar with the point.
______ Good view (Fair) 1 2 3 4 5 (Excellent)
______ Poor view (Fair) 1 2 3 4 5 (Terrible)

****

POINT 4 ______ Not familiar with the point.
______ Good view (Fair) 1 2 3 4 5 (Excellent)
______ Poor view (Fair) 1 2 3 4 5 (Terrible)

****

POINT 5 ______ Not familiar with the point.
______ Good view (Fair) 1 2 3 4 5 (Excellent)
______ Poor view (Fair) 1 2 3 4 5 (Terrible)

****

POINT 6 ______ Not familiar with the point.
______ Good view (Fair) 1 2 3 4 5 (Excellent)
______ Poor view (Fair) 1 2 3 4 5 (Terrible)

****

POINT 7 ______ Not familiar with the point.
______ Good view (Fair) 1 2 3 4 5 (Excellent)
______ Poor view (Fair) 1 2 3 4 5 (Terrible)

****

POINT 8 ______ Not familiar with the point.
______ Good view (Fair) 1 2 3 4 5 (Excellent)
______ Poor view (Fair) 1 2 3 4 5 (Terrible)

****

POINT 9 ______ Not familiar with the point.
______ Good view (Fair) 1 2 3 4 5 (Excellent)
______ Poor view (Fair) 1 2 3 4 5 (Terrible)

****

POINT 10 ______ Not familiar with the point.
______ Good view (Fair) 1 2 3 4 5 (Excellent)
______ Poor view (Fair) 1 2 3 4 5 (Terrible)

****

Experiment 2 -- Imagine you are going to build a seasonal home or camp along the shoreline. How would you rate these points on the basis of their desirability (i.e., proximity to business, road access, lay of the land, etc.) for such a structure? (Do not consider quality of the lake water in your decision.)

****

POINT 1 ______ Not familiar with the point.
______ Good location (Fair) 1 2 3 4 5 (Excellent)
______ Poor location (Fair) 1 2 3 4 5 (Terrible)

. . . . .
. . . . .
. . . . .
. . . . .
. . . . .

POINT 10 ______ Not familiar with the point.
______ Good location (Fair) 1 2 3 4 5 (Excellent)
______ Poor location (Fair) 1 2 3 4 5 (Terrible)

Experiment 3 -- Imagine you wanted to go fishing. How would you rate the fishing experience at each of the designated points?

****

POINT 1 ______ Not familiar with the point.
______ Good location (Fair) 1 2 3 4 5 (Excellent)
______ Poor location (Fair) 1 2 3 4 5 (Terrible)

. . . . .
. . . . .
. . . . .
. . . . .
. . . . .

POINT 10 ______ Not familiar with the point.
______ Good location (Fair) 1 2 3 4 5 (Excellent)
______ Poor location (Fair) 1 2 3 4 5 (Terrible

Experiment 4 -- Imagine you wanted to go swimming with your family. Assuming that the quality of the water is the same, how would you rate these locations in terms of their desirability for swimming?

****

POINT 1	______ Not familiar with the point.							
	______ Good location	(Fair)	1	2	3	4	5	(Excellent)
	______ Poor location	(Fair)	1	2	3	4	5	(Terrible)
.	.	.			.			.
.	.	.			.			.
.	.	.			.			.
.	.	.			.			.
.	.	.			.			.
POINT 10	______ Not familiar with the point.							
	______ Good location	(Fair)	1	2	3	4	5	(Excellent)
	______ Poor location	(Fair)	1	2	3	4	5	(Terrible)

Experiment 5 -- Again imagine that you want to go swimming with your family. The quality of the water as measured by the presence or absence of aquatic weeds, algae and bacteria varies between the ten points. How would you rate these locations in terms of their desirability for swimming with your family based on these water quality differences?

POINT 1	______ Not familiar with the point.							
	______ Safe	(Fair)	1	2	3	4	5	(Excellent)
	______ Unsafe	(Fair)	1	2	3	4	5	(Terrible)
.	.	.			.			.
.	.	.			.			.
.	.	.			.			.
.	.	.			.			.
.	.	.			.			.
POINT 10	______ Not familiar with the point.							
	______ Safe	(Fair)	1	2	3	4	5	(Excellent)
	______ Unsafe	(Fair)	1	2	3	4	5	(Terrible)

Experiment 6 -- Imagine that you would like to boat in the vicinity of the various points. Are algae and aquatic weeds present in sufficient quantities to detract from the boating experience?

****

POINT 1	______	Not familiar with the point.						
	______	Yes	(1	2	3	4	5)	(A lot)
	______	No	(1	2	3	4	5)	(None)
.	.		.			.		
.	.		.			.		
.	.		.			.		
.	.		.			.		
.	.		.			.		
POINT 10	______	Not familiar with the point.						
	______	Yes	(1	2	3	4	5)	(A lot)
	______	No	(1	2	3	4	5)	(None)

Experiment 7 -- Rate the quality of the water at each point.

****

POINT 1	______	Not familiar with the point.							
	______	Good	(Fair)	1	2	3	4	5	(Excellent)
	______	Poor	(Fair)	1	2	3	4	5	(Terrible)
.	.			.		.			.
.	.			.		.			.
.	.			.		.			.
.	.			.		.			.
.	.			.		.			.
POINT 10	______	Not familiar with the point.							
	______	Good	(Fair)	1	2	3	4	5	(Excellent)
	______	Poor	(Fair)	1	2	3	4	5	(Terrible)

Experiment 8 -- Rate the ten points according to scenic beauty. If you cannot differentiate between two or more points, put them on the same line.

Best ______________________________

____

____

____

____

____

____

____

____

Worst ______________________________

Experiment 9 -- Rate the ten points according to quality of the water. Again, if you cannot differentiate between two or more points put then on the same line.

Most polluted ______________________________

____

____

____

____

____

____

____

____

Least polluted ______________________________

Table 9--Average rating for each location point for all experiments

	Experiment number								
	1	2	3	4	5	6	7	8	9
Point 1	8.6	8.3	8.2	8.3	8.3	8.7	7.1	7.1	9.0
Point 2	9.0	7.4	7.9	7.4	7.5	6.2	6.2	7.8	7.2
Point 3	8.8	7.2	7.0	7.2	6.9	5.5	5.5	7.5	6.8
Point 4	7.9	5.8	6.1	5.3	5.9	4.4	4.4	5.8	5.1
Point 5	7.6	4.6	7.1	5.2	5.6	2.9	2.9	4.1	3.1
Point 6	7.8	3.9	4.6	4.8	4.3	1.6	1.6	4.7	1.4
Point 7	7.1	4.3	5.6	5.5	5.6	3.1	3.1	5.6	2.8
Point 8	7.9	6.1	7.4	6.8	7.1	4.2	4.2	6.3	5.2
Point 9	8.4	6.9	8.2	7.3	7.6	5.5	5.5	7.2	6.2
Point 10	8.5	7.6	8.7	8.5	8.3	6.4	6.4	7.6	8.8

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